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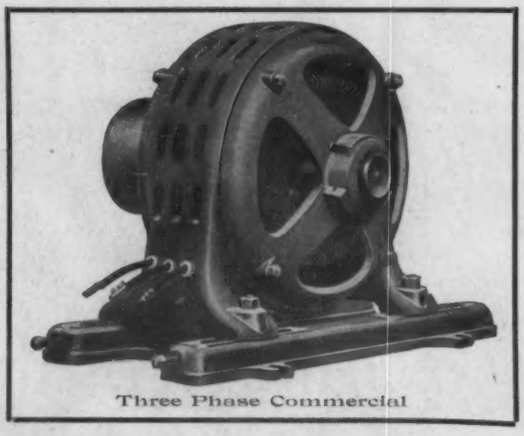

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VOLUME XVIII. SAN FRANCISCO, CAL., MARCH 2, 1907 No. 9

The Alameda Municipal Light Plant

The city of Alameda, on account of its superior climate and its nearness to San Francisco, with which it is connected by two local train and ferry lines, is primarily the dwelling place of thousands of people whose occupations take them daily to the latter city. Alameda is noted for its many beautiful homes and gardens and as a convenient summer resort for San Francisco people who desire to spend their summer evenings and holidays in the atmosphere of the country. The population is about 20,000.

About eighteen years ago a small electric plant of about 50 kilowatts capacity was purchased by the City Trustees from its private owners. Since then this has developed into the present municipal plant which supplies all the electrical energy needed by the city for public and private lighting and for power purposes.

VIEW SHOWING TYPICAL STREET LAMP ON PARK STREET, ALAMEDA

The plant was not a paying investment until within a few years ago, when it was reorganized on a strictly business basis. Politics was eliminated as the controlling factor

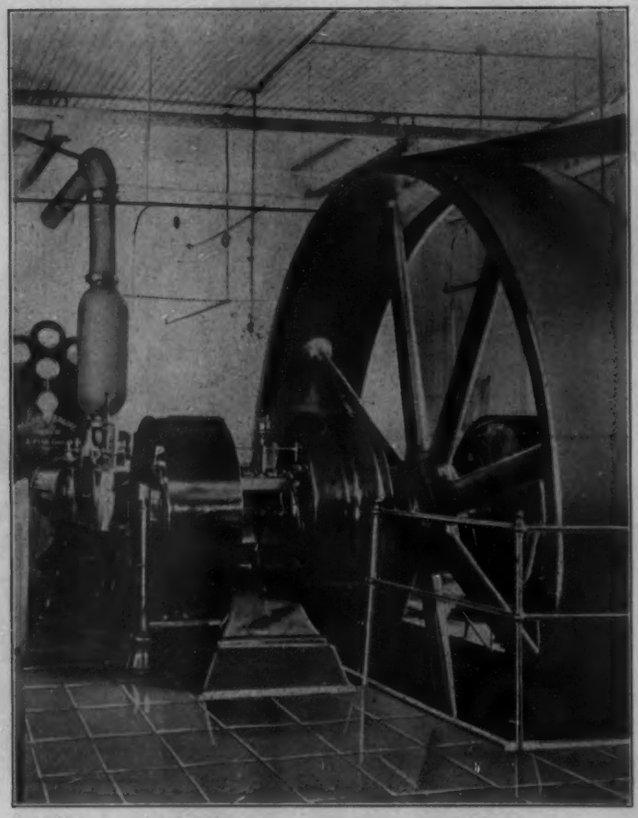
in the selection of employees. The maintenance of plant and outside equipment after the manner of private power plants has resulted in substantial profits, out of which new apparatus has been purchased to meet the increasing demand for power from private consumers.

From July 1, 1905, to June 30, 1906, the electrical output in kilowatt-hours was 941,680 for commercial lighting and power and 202,405 for municipal lighting, making a total output of 1,144,085 kilowatt-hours.

The earnings from the sale of electric power for the same period were as follows:

City lighting	$20,594.45
Commercial lighting	29,504.30
Commercial power	2,417.20
Total	$52,515.95

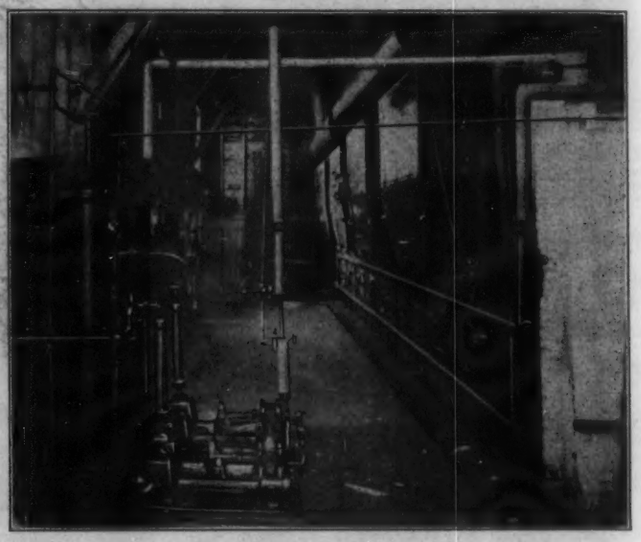
The total cost of operation, including interest on bonds and depreciation, amounted to $36,455.11. The earnings from private consumers increased 43.5 per cent. over the earnings of the preceding year and nearly 100 per cent. over the earnings of the next preceding year. During the year 1905-06, 11,988 barrels of fuel oil were used.



BUCKEYE ENGINE BELTED TO THE RESERVE GENERATOR

The present rate for the ordinary private consumer is 7½ cents per kilowatt-hour, with a minimum monthly charge of one dollar. In order to secure a reasonable day load, the rate for power has been set at 3½ cents per kilowatt-hour. The city is charged $4.50 per month for each arc-lamp maintained for public lighting.

In the residence and outlying districts the streets are lighted by incandescent lamps, usually of 25 candle-power, supported singly by iron brackets fastened to the street poles. These are supplemented by arc-lamps suspended from steel towers in groups of three, or from pole brackets or span-wires. The incandescent lamps are connected in series on 2400-volt circuits. There are at present about 150 arc-



THE BOILER ROOM

lamps and 500 incandescents in use. About 50 more arc-lamps are to be installed in the near future.

On Park street, which is the principal business street of the city, the street-lamps are of the type shown in the accompanying photograph, being similar to those in use on Spring street, Los Angeles. Each lamp requires about 280 watts.

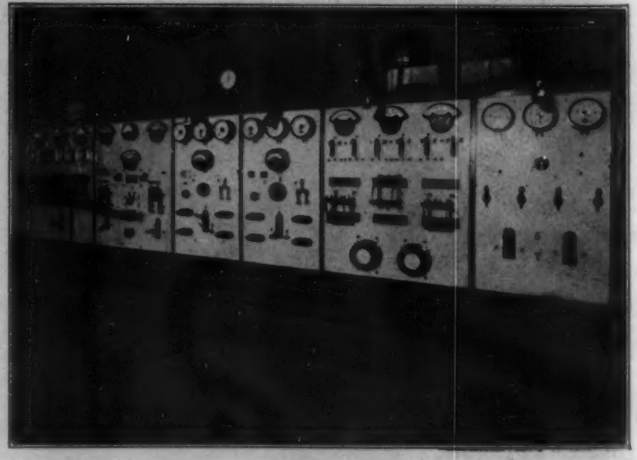
On June 30, 1906, the city had 1,424 poles in use on the streets, supporting 174 miles of wire, distributed as follows:

Commercial circuits, primary	70 miles
Commercial circuits, secondary	65 miles
Street lighting, arc circuits	27 miles
Street lighting, incandescent circuits,	12 miles

Transformers to the number of 214 were in use at that time, and 1,039 watt meters were installed on the premises of private consumers.

The power-house is a large wooden building situated at the foot of Park street, about 200 feet from the beach, washed by the San Francisco Bay. In the rear of the building are the water and fuel oil tanks and the stable for the horses used by the department. The City Trustees recently purchased an adjoining lot for the storage of construction materials.

To improve the service and meet the demand for electrical power, two new units having an aggregate capacity of 720 horse-power were installed within the past two years,



THE SWITCHBOARD.

while the auxiliary equipment was overhauled and extended so as to modernize the entire plant. On account of its proximity to the Bay, all the engines are operated condensing.

Of the three units now in operation, the oldest was installed about ten years ago and is now used only as a reserve. The engine is a Buckeye, cross-compound, double-valve engine, 17½ by 32½ inches, by a 32-inch stroke. The flywheel is 15 feet in diameter, from which a 32-inch belt drives a Stanley 240 kilowatt, 2400-volt, two-phase, induction type, alternating current generator. This machine generates at 66 cycles, thus making it impossible to parallel it with the new 60-cycle machines. It is, therefore, only used on independent circuits. The exciter is a Mather, two-pole machine, belted to the shaft of the generator. It supplies exciting current at 120 volts.

THE CITY PARK WHERE THE FEEDWATER WELL IS LOCATED.

About two years ago a new unit was installed, which consists of a Harrisburg 360 horse-power, tandem compound, side crank, piston-valve engine direct connected to a National two-phase, 2400-volt alternator. The size of the engine is 19 by 32 by 20 inches. The speed-changing device is operated by a handwheel through a worm gearing. The alternator is a 48-pole machine of the revolving field type, and is rated at 240 kilowatt at 150 revolutions per minute. The field excitation is supplied by a belted, National, 26-kilowatt, 125-volt generator running at 1,225 revolutions per minute.

The third unit, which completes the generating equipment of this plant, has been in operation about a month. The alternator is a National machine of 275-kilowatt capacity and is similar to the one just described. The exciter for this second direct connected unit is a duplicate of the exciter for unit No. 2.

Direct connected to this alternator is also a Harrisburg tandem-compound engine, but of the four-valve type, embodying many of the most modern features of steam engine design. The speed-changing device is electrially operated by two General Electric, direct current, series motors of ¼-horse-power rating, mounted on the flywheel. The speed is varied by the manipulation of a switch on the main switchboard. The engine is rated at 360-horse-power and is of dimensions, 17½ by 34 by 22 inches.

At night, and when the day load is heavy, the two National alternators are operated in parallel, being brought into synchronism with the aid of a General Electric synchroscope mounted above the switchboard.

Current for the arc-lights is supplied by three Westinghouse air-cooled, regulating transformers of primary voltage equal to 2,400, and of full load capacity of 150 lights.

The remodeled switchboard consists of seven marble panels set out about five feet from the front wall to facilitate the repairing and changing of connections. The instruments are mainly of the Westinghouse or Stanley manufacture. General Electric expulsion fuses are placed between the bus bars and the line, and the main switches are oil-enclosed of the Westinghouse make. The resistance boxes for the alternator fields are mounted above the switchboard, being controlled by a handwheel through an endless chain.

Alternating current only is supplied by this plant. With the exception of the constant current maintained on the arc-lamp circuits, power is distributed from the bus-bars at 2,400 volts.

The gauge board is placed so as to be easily seen from any of the three units. There are on this board a steam gauge for indicating boiler pressure, three gauges for indicating the pressures in the different engine receivers, two vacuum, gauges, a Bristol recording gauge, and an Ashcroft clock.

The engines exhaust into two Deane jet condensers, 10 by 20 by 24 inches, arranged with independent suction from the Bay, a distance of about 200 feet. The heated water from these is passed through a Day feed water heater and purifier, rated at 500 horse-power, placed in the adjoining fire-room. The feed-water is normally fed to the boilers from the heater at a temperature of 197 deg. F.

There are two Worthington duplex steam pumps, 6 by 4 by 6 inches, duplicate connected on both the steam and suction ends. Each pump has a gauge to indicate the pressure in the feed-water mains. One pump is controlled by an automatic regulator connected to the heater, and the other from the main steam header.

Four boilers of the return flue, tubular type, are set in battery, with a steel stack for each two boilers. These four boilers are each rated at 135 horse-power and are 6 feet in diameter an 16 feet long. Each furnace is equipped with a "Little Giant" oil burner.

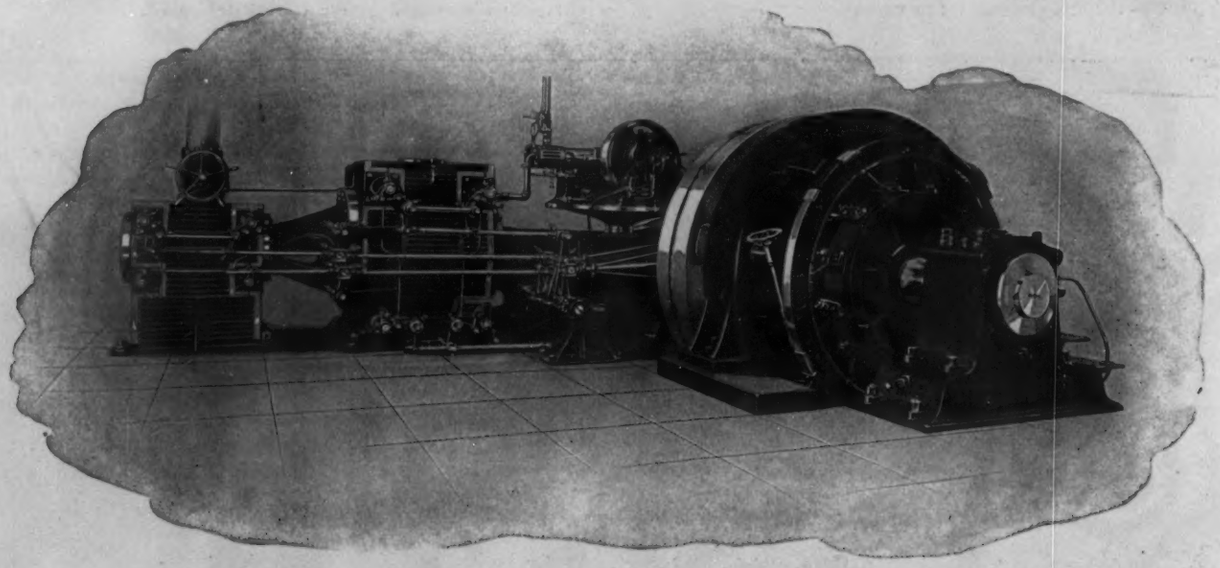
The steam main and the separators of each engine drain into 12-inch Crane steam traps, which discharge into the header of the feed water heater. Steam is supplied to each engine through 6-inch steam pipes.

The fuel oil is pumped from the storage tanks by two Smith-Vaile duplex oil pumps, 4½ by 3 by 4 inches, doubly connected to the suction pipes. A Worthington oil meter registers the quantity consumed in gallons.

There are four wooden oil tanks of about 1,000 barrels capacity, placed in pits in the rear of the power-house. Since the bottoms of the tanks are below the water line, they are securely anchored, as otherwise they would tend to float in the accumulated water. According to the existing contract, the cost of fuel oil per barrel delivered to the tanks is 75 cents.

Feed water of an excellent quality is obtained from a 12-inch well recently sunk in the City Park, about 1,200 feet away. The well is 249 feet deep. The water is pumped to the tower near the power house by a pump driven by a Westinghouse 2-phase, 10 horse-power, 220-volt motor, controlled by an auto-starter, in the fire-room. The stroke of the pump is indicated by an incandescent lamp placed in a circuit alternately opened and closed by contacts on the arm of the pump rod. The two tanks, mounted one above the other, have a capacity of about 15,000 gallons. They are elevated to such a height that the water is fed to the boilers under a 20-foot head.

Mr. Jos. B. Kahn, the present superintendent of the plant, is also the city electrician and superintendent of the fire alarm systems, which are operated by storage batteries.



TYPE OF HARRISBURG FOUR-VALVE ENGINE IN USE IN ALAMEDA MUNICIPAL PLANT.

STANDARD CELLS.

Messrs. K. E. Guthe and C. L. von Ende gave some interesting particulars concerning the performance of standard cells in a paper which they presented at a meeting of the Physical Society at Chicago. They constructed some standard cells with electrolytic mercurous sulphate prepared by themselves and with sulphate received from Dr. Hulett. The agreement between the E. M. F.'s for cells of the same series is within 2 in 100,000. Slight variations in the method of construction were made, and their influence upon the E.M.F. determined. Comparison of these new cells with those used last year for the obsolete determinations showed that the Clark cells agreed with the old, but that the cadmium cells had a considerably higher E.M.F. than the old, the changes of which were quite irregular. The authors found that while the initial E.M.F. of the new cadmium cells agrees very closely with the value found by Hulett for freshly set up cells, it decreases rapidly in a few weeks, and has now a value of 0.001 volt lower than at first. Mercury distilled twice in an ordinary vacuum still gives the same results as mercury distilled by Hulett's method. No difference was noticed between amalgam prepared in the usual way and electrolytic amalgam. Clear and cloudy cadmium sulphate crystals produce no difference in the E.M.F. of the cadmium cells. Clark cells with electrolytic coarsely-grained mercurous sulphate have immediately after construction an E.M.F. of 1.4204 volts at 25 deg. C. within a few hundred-thousandths of a volt, and remain constant in course of time. Cadmium cells with practically identical electrical behavior cannot be constructed at the present time.

POWER DISTRIBUTION FOR ELECTRIC RAILWAYS

Mr. Elbert G. Allen.*

In laying out feeder systems for distributing low voltage current to electric railways there are three objects to be kept in mind:

First, to provide sufficient copper that the feeders may not be dangerously overheated by the amount of current they convey.

Second, to provide sufficient voltage at all points that the desired schedules may be maintained without forcing the motors to a dangerous degree.

Third, to keep the actual power loss in the feeder circuit to an economical point.

As a rule in all but very short urban feeders the first object is attained in providing for the other two, but it should never be overlooked. The lack of voltage being the thing which is usually reported in a case of insufficient copper, too great stress is often laid on this requirement to the detriment of the others, particularly the third.

The simplest form of feeder system is that in which the working trolley is the only conductor employed, and is uniform in size from end to end. The so-called ladder system (Fig. 1) of feeder arrangement is a simple modification where the trolley being insufficient, a second wire is connected in multiple with it.

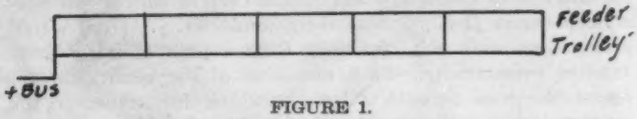


FIGURE 1.

If more copper is desired near the station end where the current density is greater it may be provided by using a tapering feeder or as is more practical, by adding short lengths of additional conductors at this end (Fig. 2).

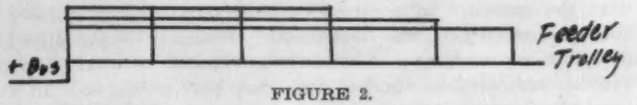


FIGURE 2.

In order to maintain a more uniform pressure from end to end of the trolley, the feeders are sometimes kept separate as in Fig. 3.

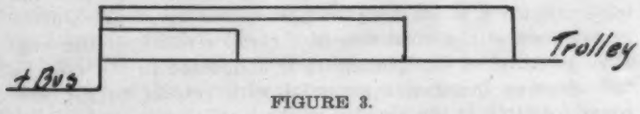


FIGURE 3.

In any of these cases the trolley may be sectionalized and switches placed in the feeder taps so that sections may be killed in case of fire, etc.

Many combinations of these simple feeder systems may be made, as for example, in Fig. 4, where the station end is fed by a tapered feeder and pressure held up on the remote end by a separate feeder.

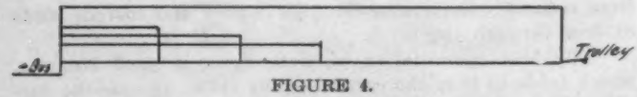


FIGURE 4.

This scheme is often employed where some particular point of the line, as a long steep hill, requires particularly large feeder capacity. It is also employed frequently where the pressure at the outer end of a line is held up by a "boosted feeder."

In the calculation of feeder systems it is necessary to make some assumptions of size and distribution of loads. In interurban service it is often possible to assume actual locations and size of loads from current time curves, but for urban and suburban work it is often more satisfactory to assume a distributed load. In the average case where grades are not excessive a uniform distribution of load may be satisfactorily assumed.

In figuring economical distribution of copper, two objects may be kept in mind, the delivery of a specified minimum voltage or the maintenance of a specified maximum loss. It can be easily proved that with uniform distribution of load the cross section of total copper should vary as the square root of the distance from the far end for minimum weight of copper to give a given voltage drop. For minimum copper with a given watt loss, the section of copper should be directly proportional to the distance from the far end.

Taking the case where a given maximum voltage drop is desired since the cross section of copper is to vary as the square root of the distance from the far end,

$$y = k\sqrt{x}$$

where y equals c.m. area of copper at distance x from the end.

$dv = \frac{10.5\,a\,x\,dx}{y}$ = drop in an elementary section of feeder where a = current distributed per unit length of feeder.

$$\text{Then } dv = \frac{10.5\,a\sqrt{x}\,dx}{k}$$

$$v = \frac{10.5\,a}{k}\int_0^L \sqrt{x}\,dx = \frac{10.5\,a}{k} \cdot \frac{2}{3}\left(L\right)^{\frac{3}{2}} = \text{Total drop}$$

$$k = \frac{2}{3}\,\frac{10.5\,A}{V}\sqrt{L}$$

where L = total length of line,
A = total length of amperes,
V = maximum drop in volts.

For example, a road 15,000 feet long with No. 00 trolley giving five minutes' service with 18-ton cars at schedule speed of 45 minutes for the round trip, is assumed to consume 135 watt hours per ton mile, with a 40 per cent load factor.

No. of cars = 9,

$$\text{Average load} = \frac{9 \cdot 18 \cdot 30000 \cdot 4 \cdot 135}{3 \cdot 5280} = 165 \text{ kilowatts}$$

Max. load = 410 K. W. or 685 amps.

Allowing 100 volts' drop to the end we find,

$$k = \frac{2}{3}\,\frac{10.5\,685}{100}\sqrt{15000} = 5870$$

$$y = 5870\sqrt{x}$$

This curve of distribution of copper is shown in Fig. 5. The total circular mill feet required is 7,200,000,000.

Such a distribution is of course impractical, and commercially we would substitute steps composed of standard size copper. For example we might use

No. 00 Trolley - - -	15000 feet.
No. 4/o Feeder - - -	5000 feet.
500,000 C. M. Feeder - -	8500 feet.

Total C. M. feet = 7,308,000,000
Actual drop = 102 volts,

which, employing 1½ per cent more copper, gives only 2 per cent excess drop over that obtained by a theoretical distribution.

*Lecture delivered January 9, 1907, to Class in Electric Railways, in the University of Washington, Seattle, Wash.

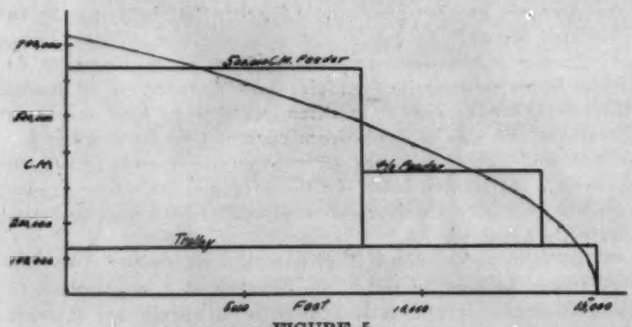


FIGURE 5.

For the calculation of stepped feeders the following formula is useful:

Fig. 6, let a = current per unit length,

$$\text{Drop in } dx = \frac{10.5\ a\ x\ dx}{y_2}$$

$$\text{Total drop in section} = \frac{10.5\ a}{y_2}\int_{l_1}^{l_2} x\,dx$$

$$= \tfrac{1}{2}10.5\ a\left[\frac{l_2^2 - l_1^2}{y_2}\right]$$

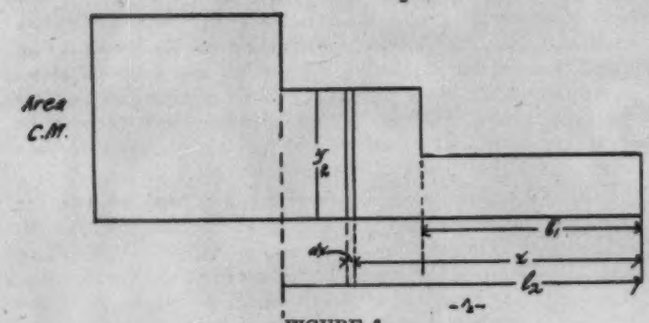


FIGURE 6.

In case it is not a fair assumption that the load is uniformly distributed from end to end of the line, it is still true in general that for the most economical arrangement of copper for a given voltage drop at the end, the copper should everywhere be proportional to the square root of the current flowing, and for most economical arrangement with a given watt loss the section should be directly proportional to the current therein.

With suburban roads where service is infrequent and there are portions of the route which have a specially heavy demand, it is frequently better to assume concentrated loads rather than assume a uniform distribution. It is usually sufficient to assume a case where one car is at the extreme end of the line, all others being located in their proper place according to schedule and assign loads to the various cars in accordance with the character of the road where they are located. The sum of the loads should correspond to the assumption for the total maximum loads, and starting demands should be assigned to the more remote cars in order that extreme conditions may be figured on.

If a section of road is fed from both ends and a concentrated load is assumed, as is the case with an ordinary interurban road with several sub-stations, it is usually best to have the conductor of uniform cross section from station to station unless there are points of unusually heavy demand. This follows from the propositions given above for economical distribution of copper, as the current is the same in all sections from the train to the sub-station.

All the above discussion refers to the positive feeder only, and neglects the resistance of the return conductor. Steel rail is of very variable resistance, depending on the composition. The purer and softer the steel the better is its conductivity. Manganese most affects the conductivity, while phosphorus also increases the resistance greatly. It is generally safe to assume that steel has about one-seventh the conductivity of copper, or perhaps a little less. The equivalent section of copper in circular mills is then equal numerically to about 16,000 times the weight of the rail in pounds per running yard. The return circuit has then a resistance of from 0.1 or 0.2 that of the positive circuit with very good conditions on small systems, an amount nearly equal to it with poor conditions on very large systems. In the ordinary suburban case the return resistance is about one-third the positive resistance. One very good way of taking care of the return resistance in approximate calculation is by substituting 14 for 10.5 as a value of specific resistance in the ordinary formulae for voltage drop. It is usually best, however, to take care of it by some more close method, figuring the equivalent amount of copper resistance added by the rail circuit.

In the foregoing we have assumed that rail joints add nothing to the resistance of the track circuit. This is hardly true, except possibly for newly bonded tracks under the best conditions. An ordinarily well bonded track should not, however, show less than 85 to 90 per cent of the conductivity of an equal length of continuous rail.

The assumption has also been made that the track forms the sole path for the return of the current. This also is not true, although it is sufficiently near the truth to form a conservative basis for the calculation of voltage drop. In accordance with Ohms law the return current follows all possible paths in proportion to their conductivity. Iron, water, and gas mains not infrequently form a path of fairly good relative conductivity. Such diversion of the return current opens the way for electrolytic troubles, for wherever the current leaves a metal electrolysis will take place, provided there is a suitable electrolyte present. The best electrolytes are chlorides, nitrates, or sulphates. The mere passage of current over a pipe does not necessarily imply that electrolysis is taking place, for there must be a departure of the current from the pipe through a proper electrolyte. Neither does the presence of a pitted or worn pipe near a railway track necessarily imply electrolysis. Probably every pitted and thin pipe whose condition is attributed to electrolysis can be duplicated by similar pipes that have never been in a locality where electric current could pass through them, and have been acted on by chemical agencies only. A difference in potential between pipe and rail is not true measure of the amount of current passing between them or the amount of electrolysis taking place. It does, however, indicate the tendency towards electrolytic action, and is often valuable as evidence of the condition of the rail circuit. If the negative terminal of the generators is connected to the rail the rail assumes a negative potential with respect to the surrounding earth in the vicinity of the powerhouse, and a positive potential in outlying districts. The district where the rail is negative is called the danger district, for it is here that current tends to leave pipes for the rail and cause electrolysis of the pipes.

If the network of pipes is connected to the negative terminals of the generators, no electrolysis can take place as before by the current leaving the pipe, but electrolysis is liable to take place at all rail joints where conductivity from section to section of the pipe is poor and current tends to flow through the earth.

The best preventative of electrolysis is good bonding, which tends to keep the current in the rails. In case the current density becomes so high that the difference in the potential in the danger district becomes more than four or five volts, the rail should be supplemented with ground feeders. In some instances where pipes are particularly liable to damage, it is wise to lay a ground feeder paralleling the pipe and connected to it every few pipe lengths throughout the danger district.

SINGLE-PHASE VS. THREE-PHASE POWER TRANSMISSION.

Ernest Van Loben Sels.

It has become an accepted principle among electrical engineers that mathematically one-quarter of the copper in a transmission line is saved by the use of three-phase transmission. Of course, there can be no doubt that three-phase transmission requires one-quarter less copper for the same voltage between the wires, than the single or two-phase systems, but it is worth while to see how that saving is effected.

Since the copper in any given system varies inversely as the square of the voltage, and since the limit to higher voltages is only the capability of the insulation to withstand the increased strain, it follows that the condition for comparison of single with three-phase transmission must be an equal strain on the insulation in either case.

Now, in wet weather—and this is the most unfavorable condition for the insulators, and, therefore, the one to be considered—the pole and cross-arms become conductors connected to earth, and, therefore, their potential is and remains zero throughout the cycle, regardless of any inequality of leakage over the insulators. In dry weather the sum of the leakages from all the insulators on one pole, which would be zero in any balanced system if the insulators were all equally clean, may affect the potential of the pole to some extent, due to an unequal accumulation of dirt and moisture on the insulators, making the potential rise and fall in step with the wire over the dirtiest insulators. In practice, however, this effect will be small compared to the line voltage, because (a) the insulators must be kept clean enough to minimize the leakage in order to avoid destructive carbonizing; (b) the leakage would be very small in dry weather, as the dry dirt is not a good conductor. What little variation there may be is likely to occur in both single and three-phase transmission, so that, both systems being affected alike, this variation from zero potential may be neglected, and the potential of the pole considered to be always zero.

The voltage which the insulators of a three-phase transmission line must be designed to withstand is, therefore, the maximum difference of potential between any one wire and the neutral. The insulators being merely a set of high resistances star-connected, and each insulator is subjected to the same strain as would each of a set of star-connected transformers. Of course, for purposes of comparison, while dealing with the same wave-form in the two systems, it is perfectly allowable to use the mean effective voltage instead of the maximum voltage, because they bear the same ratio to each other in both systems. Making this substitution, the insulators in a single-phase line with a line voltage=E, would each have to withstand E/2 volts, while, for the same voltage between the wires in a three-phase, star-connected line, each insulator would have to withstand $\frac{E}{\sqrt{3}} = \frac{E}{1.732}$ volts. If the voltage be raised on the single-phase line to $\frac{2E}{\sqrt{3}} =$ 1.155-E, the strain on the insulators would then be equal to that on those of the three-phase line with E volts between the wires. If E_3 and I_3 represent voltage and amperage in the three-phase line, and E_1 and I_1 the voltage and amperage in the single-phase line, then for a power of P watts at power-factor p, we have in the three-phase line $P = \sqrt{3}\ p\ E_3 I_3$ or $I_3 = \frac{P}{\sqrt{3}\ p\ E_3}$ and in the single-phase line $p = p\ E_1 I_1 = \frac{p\ 2\ E_3}{\sqrt{3}} I_1$ or $I_1 = \frac{P\sqrt{3}}{2p E_3} = \frac{P}{\sqrt{3}\ p\ E_3} \cdot \frac{3}{2} \cdot : \frac{I_3}{I} = \frac{3}{2}$ for the same power, power-factor and the same strain on the insulation. That is, the current in each of the two single-phase wires would be fifty per cent greater than the current in each of the three three-phase wires. Consequently the total current in all the wires of one system would equal the total current in all those of the other, and, under these conditions, the copper required would be the same for both systems.

Incidentally, the wires of the single-phase system would have to be spaced fifteen and one-half per cent, further apart if it is desired to keep the same factor of safety on the atmospheric dielectric—and it must be noted here that this is the only part of the whole system which would be subjected to a greater strain than would be incurred with a three-phase line with the same voltage between wire and neutral. The cross-arms would therefore be a little longer than would be necessary for our three-phase line—a trivial item which would be more than counterbalanced by rendering unnecessary the extra length of pole required to support the third conductor of a three-phase line.

In conclusion, then, it is evident that while for the conventional comparison with equal voltage between the wires, the three-phase system shows a saving of twenty-five per cent. of the copper in the transmission line, this saving is not effected by any inherent superiority of this form of transmission, but is only secured by increasing the strain on the insulators; and that, if the voltage be raised on the single-phase system until the same strain is imposed on the insulators, then both systems require the same quantity of copper, but the single-phase system requires one-third less insulators, insulator pins and lightning arresters. This means not only a smaller first cost for the single-phase line, but also one-third less insulators to keep clean and replace when broken, and less chance for a ground. Indeed, to claim any superiority for the three-phase system on the ground of saving in copper in this manner is on a par with advocating shallow trusses for bridge construction on the ground that metal is saved by shortening the vertical and diagonal members; and all the while not taking into consideration the fact that the strains in most of the members will thereby be increased. and that therefore any saving in metal is only effected at the expense of the safety factor.

In the transmission of power running high up into the thousands of kilowatts, this saving of one-third of the insulator pins and lightning arresters may not be worth taking into consideration as against the great advantages of the three-phase system; the greater starting torque of all three-phase motors, less tendency to hunt and get out of step, and the higher efficiency and lesser weight of both generators and motors. But in the transmission of power in small quantities the matter is entirely different. Experience has proved that small wires are objectionable because they break too easily. Consequently in transmitting only a few hundred kilowatts an amount of copper is used in excess of the requirements for the power transmitted. In such a case one-third of the copper can be saved by transmitting single-phase and using only two wires. The question of the advisability of transmitting single-phase will then depend on the use to which the power is to be put. For electric lighting purposes single-phase current shows some advantages over three-phase current because it is easier to balance the two sets of lights in a three-wire, single-phase system, than to balance the three sets of a three-phase, four-wire system. Similarly single-phase current is better for charging storage batteries or for any electrolytic purpose whatever, as it requires but one mercury arc rectifier as against three in the three-phase system—quite an advantage when small amounts of power are so used. Where there is no objection to a frequency of twenty-five cycles, single-phase current is vastly superior to three-phase for electric traction, as the former can be used directly, without the interposition of any other machinery than step-down transformers in the "single-phase" railway motor—an ordinary series motor with laminated poles, and designed for minimum sparking. For long-distance traction this arrangement greatly reduces the size of trolley feeders and the number of sub-stations required, as well as eliminating all rotating machinery.

Furthermore, the single-phase railway motor, which is only recently on the market, has undoubtedly many other possibilities as yet unexploited. Thus it could undoubtedly

be used for driving hoists and elevators, as its characteristics make it peculiarly fit for work requiring very high starting torque, and running at variable speed. In fact, it might even be adapted for operating machines in machine shops where the individual drive is introduced. Geared directly to its machine, all speed variation over any ratio desired could be obtained by varying the e. m. f. delivered by a transformer, doing away entirely with resistance coils, as in a D. C. machine. In fact, it should compare well with D. C. motors in regard to average running efficency, as its greater efficiency at low speeds should more than offset its lower efficiency at full speed. Then ordinary single-phase motors can be used for driving machinery that can be started up under no load, and where the load is constant, as, for instance, centrifugal pumps, fans, etc.; and single-phase rotary converters are entirely satisfactory for generating D. C. current. Also in small motors generally, where a friction clutch can be used and the motor started off by hand, single-phase current can be used.

On the other hand, where heavy machinery must be started under full load, and the load is intermittent, as in mills for instance, a single-phase motor would be an impossibility, and the question of the advisability of transmitting single-phase where part of the power is to be used for such a purpose, would depend on the relative amounts of power to be used for this and for other purposes, more suitable to single-phase current—or whether the mills were so located that they could be supplied with D. C. current from one central sub-station in connection with a storage battery, for instance. This question must be solved with especial regard to the peculiarities of each individual case. Enough has, however, been said to show that the much-maligned single-phase transmission of power is not without its advantages, and that there is quite a field in small power transmission where it is superior to three-phase transmission.

ON THE SUBSTITUTION OF THE ELECTRIC MOTOR FOR THE STEAM LOCOMOTIVE.

Few subjects which are to-day engaging the attention of the engineering world are comparable either in scientific interest or in practical importance to the substitution of the electric motor for the steam locomotive engine. On the Valtellina line and through the Simplon tunnel 70-ton electric locomotives, with three-phase motor equipment, capable of developing a draw-bar pull of 28,000 lbs., have displaced the steam locomotive, with results showing both marked improvement in service and substantial economy in operating costs. In the New York subway, eight-car trains weighing 320 tons are in operation, equipped with motors developing during acceleration a tractive effort equivalent to a draw-bar pull of 55,000 lbs. The heaviest passenger locomotive used on the Erie system weighs, exclusive of tender, 206,000 lbs., of which 55.8 per cent., or 115,000 lbs., is effective on drivers. Assuming the adhesion to be 20 per cent., such a locomotive exerts a draw-bar pull of 23,000 lbs. The motors of the eight-car electric train of the New York subway, therefore, exert a tractive effort equivalent to more than twice the draw-bar pull of this locomotive.—Extract from address by Lewis B. Stillwell and Henry St. Clair before the American Institute of Electrical Engineers.

AN IMPROVEMENT IN ELECTRIC SIGNS.

Brilliant effects for electric signs are now to be readily obtained with little cost by the use of small, colored, transparent caps which fit over the rounded ends of the incandescent bulbs. This permits the owner of a changeable electric sign to alter the legend at will and to indulge in the use of colors without the necessity of keeping on hand a large supply of colored lamps, some of which are very expensive.

LIMITING CAPACITIES OF LONG-DISTANCE TRANSMISSION LINES.

Clarence P. Fowler.*

The amount of power which can be commercially transmitted over a long-distance transmission line is usually limited by the voltage regulation. The voltage regulation is the drop in voltage caused by the transmission line. It is the difference between the voltage measured at the power house and the voltage measured at the receiving station, and is usually expressed as a per cent. of the normal voltage at the receiving station. The drop in voltage is dependent upon the resistance of the line, its inductance, the frequency, the current and the power-factor of the load.

The method of obtaining the resistance of the line is well known. The inductance at a given frequency depends upon the size of the conductors and their distance apart. The inductance volts for given conditions are found from tables. The resistance volts and the inductance (or reactance) volts may be combined as two sides of a right angle triangle, the hypothenuse of which gives the line impedance. This represents the electro-motive force which would be required for sending the current through the line when short-circuited at the receiving end.

The effect of the above-mentioned line conditions, namely, the resistance volts, the inductance volts and the power-factor of the load, upon its voltage regulation is given in Table I. It will be noted by an examination of this table that the total drop when the power-factor of the load is 100 per cent. is dependent almost entirely upon the resistance and very little upon the inductance of the line; whereas, at low power-factors the inductance is a very important factor in determining the total drop. This table, it may be remarked, is applicable not only to long-distance transmission lines using high voltage, but also to all circuits which have both resistance and impedance, whether these elements be in the conducting wires themselves or in impedance coils or other devices.

At the 20th annual convention of the American Institute of Electrical Engineers in 1903, Mr. P. M. Lincoln presented a paper, entitled "Choice of Frequency for Very Long Lines." One of the elements which he takes up is the limit

TABLE I.

Total Drop at Power-factors Ranging from 60-100 Per Cent., with Different Percentages of Resistance and Inductance Volts, in Transmission Circuits.

Per Cent of Received E. M. F.		Per Cent Total Drop for Power-Factors of					
Resistance Volts	Inductance Volts	100 %	95 %	90 %	85 %	80 %	60 %
5	3	5.	5.75	6.0	6.0	5.9	5.5
5	5	5.1	6.5	6.9	7.0	7.0	7.0
5	10	5.4	8.2	9.2	10.0	10.1	11.0
5	15	6.0	10.1	11.8	12.8	13.3	15.0
10	5	10.0	11.0	11.3	11.25	11.0	11.0
10	10	10.4	12.8	13.6	14.0	14.0	14.0
10	15	11.0	14.8	16.0	16.8	17.0	18.0
10	20	11.8	16.9	17.75	19.9	20.3	22.0
15	10	15.4	17.5	18.0	18.0	18.0	17.0
15	15	16.0	18.8	20.3	21.0	21.0	21.0
15	20	16.8	21.0	23.0	24.0	24.0	25.0
15	30	18.8	26.0	28.3	30.0	31.0	33.0
20	15	21.0	24.0	24.9	25.0	25.0	24.0
20	20	21.6	26.0	27.1	27.9	28.0	28.0
20	30	23.7	30.2	32.5	33.8	35.0	36.0
20	40	26.3	35.2	38.3	40.0	41.5	44.0

*From the "Electric Journal."

of power which can be transmitted over a given line without exceeding certain limits as to voltage regulation. He gives the limiting kilowatts which may be transmitted under definite conditions at a distance of 200 miles.

The method suggested by Mr. Lincoln has been worked out for a wider range of conditions, and the results are given in Table II. In this table it is assumed that power is delivered from a three-phase line, that the conductors are six feet apart and equidistant, that the size of conductors is such as to give approximately fifteen per cent. resistance loss, and that the power is delivered at eighty-five per cent. power-factor. If the size of wire be changed, the effect upon the inductance volts will be very slight—for example, if the size of wire be increased so that the loss is reduced as much as fifty per cent., the inductance volts will likewise be decreased, but only a few per cent.

Mr. Lincoln, in the paper above referred to, makes the following statement with regard to charging current:

"Charging current is, of course, a direct function of frequency and voltage and, to a slight extent, of line construction. At 60 cycles the apparent energy represented by the charging current in a 200-mile, three-phase line is practically equal to the ultimate capacity of that line as limited by the twenty per cent. inductance volts consideration. At twenty-five cycles it is only about 15 per cent. of the ultimate capacity as limited by the same consideration. In a sixty-cyle installation, therefore, it is necessary either to operate the generators on such a line at about full-current output all the time, no matter what the load, or to compensate for the charging current in part or in whole by the installation of choke coils, either horn of which dilemma is not pleasant to consider. The problem of taking care of the charging current at twenty-five cycles does not enter the discussion as compared with sixty cycles.

TABLE II.

Approximate Kilowatts at Power-factor of 85 Per Cent; Inductance Volts 10, 15 and 20 Per Cent.; Distance 50, 75, 100, 150, and 200 Miles; Line Voltage, 20,000-100,000 Volts.

Distance and E. M. F.	10 per cent Inductance Volts		15 per cent Inductance Volts		20 per cent Inductance Volts	
	60 cycles	25 cycles	60 cycles	25 cycles	60 cycles	25 cycles
50 Miles						
20 000	900	2 300	1 400	3 500	1 800	4 700
30 000	2 000	5 300	3 000	7 900	4 000	10 600
40 000	3 600	9 400	5 400	14 100	7 200	18 800
50 000	5 600	14 700	8 400	22 000	11 200	29 400
60 000	8 100	21 200	12 200	31 700	16 200	42 300
80 000	14 400	37 600	21 600	56 400	28 800	75 200
100 000	22 500	58 700	33 700	88 000	45 000	117 500
75 Miles						
20 000	600	1 600	900	2 300	1 200	3 200
30 000	1 300	3 500	2 000	5 300	2 700	7 000
40 000	2 400	6 300	3 600	9 400	4 800	12 600
50 000	3 700	9 800	5 600	14 700	7 500	19 600
60 000	5 400	14 100	8 100	21 200	10 800	28 200
80 000	9 600	25 000	14 400	37 600	19 200	50 000
100 000	15 000	39 200	22 500	59 000	30 000	78 400
100 Miles						
20 000	450	1 200	700	1 700	900	2 300
30 000	1 000	2 600	1 500	3 900	2 000	5 300
40 000	1 800	4 700	2 700	7 000	3 600	9 400
50 000	2 800	7 300	4 200	11 000	5 600	14 700
60 000	4 000	10 600	6 100	15 400	8 100	21 200
80 000	7 200	18 800	10 800	28 200	14 400	37 600
100 000	11 200	29 500	16 900	44 000	22 500	59 000
150 Miles						
20 000	300	800	450	1 200	600	1 600
30 000	650	1 700	1 000	2 600	1 300	3 400
40 000	1 200	3 200	1 800	4 700	2 400	6 400
50 000	1 800	4 900	2 800	7 300	3 700	9 800
60 000	2 700	7 000	4 000	10 600	5 400	14 000
80 000	4 800	12 500	7 200	18 800	9 600	25 000
100 000	7 500	19 600	11 200	29 500	15 000	39 200
200 Miles						
20 000	225	600	350	850	450	1 100
30 000	500	1 300	750	1 900	1 000	2 600
40 000	900	2 300	1 300	3 500	1 800	4 700
50 000	1 400	3 600	2 100	5 500	2 800	7 300
60 000	2 000	5 300	3 000	7 700	4 000	10 600
80 000	3 600	9 400	5 400	14 100	7 200	18 800
100 000	5 600	14 700	8 400	22 000	11 200	29 500

"The effect of a large charging current on the regulation of the generator should also be considered. As is well known, a line-charging current, when circulated in a generator armature, has the effect of assisting the field ampere turns to magnetize the fields. The percentage of magnetizing done by this charging current depends upon its amount and the inherent regulation of the generator. Since the charging current depends upon the voltage, the generator exciting power of the charging current also depends upon the voltage. The effect of sudden load changes, therefore, which tend to change the voltage delivered, will in turn affect this element of the excitation. That is, to a certain extent, the generator assumes the regulation which inherently belongs to a direct-current shunt generator. The effect of large charging currents on generator regulation is therefore not toward an improvement."

As the charging current of a line 200 miles long is practically equal to the ultimate capacity of the line, when the frequency is sixty cycles and the inductance volts are twenty per cent., it follows that the charging current exceeds the normal working current when the inductance volts are less than twenty per cent. For distances less than 200 miles, the charging current is proportional to the distance and the power delivered is greater than for 200 miles. Consequently, the charging current is considerably less than the normal current for the conditions given in the table, except those for the greater distances and higher frequency and the lower inductance volts.

STUPENDOUS WATER SUPPLY SCHEME.

Three of the leading hydraulic engineers of the country have recently reported favorably upon what is probably the most daring municipal water supply scheme that has ever been projected. We refer to the proposal, which we understand, has every prospect of being successfully prosecuted, to supply the city of Los Angeles and the surrounding district with an abundant supply of water drawn from the distant Sierra Mountains. The scheme involves, first, the construction of a conduit 226 miles in length, capable of supplying the city with a quarter of a billion gallons of water daily; second, the construction of large storage reservoirs, a single one of which will have the enormous capacity of 85 billion gallons of water; and lastly, the development of a total of 100,000 horsepower, available for six days of the week and nine hours of each day, the greater part of which can be developed within a distance of 45 miles of the city. The total cost of this very ambitious undertaking will be about $25,000,000. The guarantee for planning this work on a scale of such magnitude is to be found in the certain and very large income to be derived from the sale of water for irrigation purposes and for power in and around a city which doubled its population in the ten years preceding the last census, and is recognized to-day as being, next to San Francisco, the most important commercial center in the flourishing State of California.—"The Scientific American."

A WHALEBONE DEPOSIT.

A landslide occurred in October on the Thompson ranch at Scott's Valley, at Santa Cruz, Cal., which uncovered a bed of whalebone which apparently has been there since the antediluvian period. The place where the pre-historic bones were uncovered is fully 600 feet above the sea level and six miles from the shores of Monterey Bay. Other discoveries of the kind have been made in various sections of the county, and scientists who have made a study of the geological formation of the soil at different times claim that the present site of Santa Cruz, extending as far back as the Santa Cruz Mountains, was once covered by an immense body of water.—Scientific American.

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EDITORIAL.

Electric Railway Engineering

In the field of electricity the development in connection with electric railways is of the greatest importance. Also, in the development of transportation systems, both for city service and interurban traffic, electricity has been extensively used, and, what is more important, very successfully. At the present time the engineering details involved in the installation of electric railways are in many respects different from that of either steam railway systems or the generation, transportation and distribution of electrical energy for power and light. It may, therefore, be said that electric railway engineering is in some respects a distinct field of engineering, and many matters to be considered by the electric railway engineer are different from either railway or electrical problems.

For nearly twenty years direct current at 500 volts, constant potential, has been used exclusively for electric traction purposes. Not until recently has alternating current been extensively utilized in connection with the series alternating current motor. For long lines the saving in copper, as well as increased efficiency, makes the alternating current railways in many respects superior to the direct current lines. The proper place for each is being determined today by actual installations, and although the alternating current motor requires excessive starting current as compared with the direct current motor, this advantage is being rapidly overcome and may be said to be of small importance compared to the many advantages incident to the use of alternating current direct for the motors on the cars.

Electrical energy today is primarily generated almost exclusively as alternating current, particularly where long transmission lines are required or very large units required. The elimination of sub-stations, lowering transformers, motor generator sets or rotary converters and costly feeders, all of which are necessary in long direct current 500-volt lines, gives the alternating current railway systems a decided preference, particularly as regards first cost. Judging from the reports of some of the alternating current railway systems in the East, their operation has been quite satisfactory, and in general as reliable as the 500-volt direct current lines.

Another important advance has recently been made in the substitution of 1,200-volt direct current in place of 500-volt direct current between the trolley and the rails, this increase in voltage resulting in a great saving of copper and extending the distances to which direct current lines may be economically operated. The joint use of 500 volts for city service and 1,200 volts for suburban service, using the same motors, cannot but be a great stride ahead in electric railway work, both within the city limits and for outside lines.

The Central California Traction Co., which was fully described in a recent issue of the "Journal," has an interurban system more than fifteen miles in length. Very soon there will be other lines in operation thirty-five miles from the generating station. The cars on the interurban lines will be operated from the 1,200-volt service. Within the city limits, where the cars must necessarily be operated at lower speed, a change is made from the 1,200-volt trolley to 550 volts. It is, of course, necessary that the auxiliaries on the car, such as the lights, heaters, air pump, etc., must be operated at the same voltage at all times. This is made possible by the installation of a direct current voltage changing device, which is nothing more than a motor generator set, which, when the cars are operated on outside lines, reduces the voltage from 1,200 to 550 volts. Upon entering the city, these motor generator sets are cut out and the auxiliaries operated directly on the trolley potential at 550 volts.

From the standpoint of the civil engineer, the grades and curves allowable on interurban lines are quite different from those ordinarily found on steam railway lines. This is, of course, due to the fact that single motor cars are usually operated on electric railway systems. Where electric locomotives have been installed to supplant steam locomotives, the track requirements are naturally the same as in the ordinary steam railway lines.

TRADE CATALOGUES.

The General Electric Company—Bulletin No. 4481 presents a type of Signal Relay for use in connection with railway signal apparatus. Several important points of superiority over any relay that has heretofore been used for this work are claimed, and the bulletin will be of interest to railway and signal engineers.

Bulletin No. 4482—A guide to the design of medium and small capacity central station switchboards. This bulletin will prove of assistance in the designing of small switchboards, as it represents by means of appropriate drawings the latest practice in alternating current switchboards.

Bulletin No. 4484 is devoted to Railway Signals, Top Mast, Direct Connected, Two and Three Position Type. These signals are motor-driven, and show a distinct advance in this class of apparatus.

Bulletin No. 4486.—This describes in detail the salient features of the General Electric Company's line of continuous current motors for constant speed service, which are known as the Type CQ, and range in capacity from 1-16 to 20 horsepower.

Price List No. 5159, superseding all previous issues, gives list prices of Edison Incandescent Lamps (Carbon Filament Type).

Price List No. 5160 (same as above) is devoted to Edison Miniature Incandescent Lamps, which include Candelabra Lamps, Decorative Lamps, and Battery Inspection Lamps.

Allis-Chalmers Co.—Bulletin No. 1038, a reprint on the subject of "Alternating Current Generator." It contains many illustrations showing different installations of the Allis-Chalmers' Alternators, and will be of value to all interested.

Bulletin No. 1415 on "Gates Rock and Ore Breaker," Style "D," superseding Catalogue No. 117. This machine has had a very large sale all over the world, being the first gyratory crusher to be placed on the market. This bulletin shows a number of improvements in design, workmanship and material, so that it will be found of interest to all users of such machines.

Publication No. 115, being directions for erecting Gates' Elevators. The matter in this is very plainly put with the aid of illustrations, and will, no doubt, be of value to all users of the elevator type of conveyors.

Electric Storage Battery Co.—The "Exide" Battery Instruction Book has just been revised by the Electric Storage Battery Co. The 1907 book is most complete and describes the various parts comprising the "Exide" battery, and gives in detail the method of operating and caring for the battery, as well as instructions for assembling and putting it in commission.

The book is not for sale, but is being distributed by the vehicle manufacturers, the "Exide" battery depots, and the "Exide" distributors, which are located in the principal cities throughout the country.

Upon request it will be furnished by any of the branch sales offices of the Electric Storage Battery Company.

The Risdon Iron Works.—The operation of gold dredgers has been described in a general way by the technical journals in articles which have always been of interest, but for a detailed description of all the parts, together with illustrations and drawings, we have seen nothing which compares with the new catalogue (No. 17) on gold dredging machinery issued by the Risdon Iron Works, San Francisco.

The Automatic Oil Cup Co. have just published a neat little bulletin devoted to Bang's Automatic Oil Cups. There are a number of illustrations and drawings showing the adaptability of this cup to any bearing. Applications for the bulletin should be sent to the Automatic Oil Cup Co., 155-59 Huron Street, Milwaukee, Wis.

The Sprague Electric Co. have sent out to the trade a very effective little folder showing the simplicity of Greenfield Flexible Steel Armored Conductors for an installation of electric lighting conductors as compared with the ordinary knob and tube system. This will appeal to all engineers and wiring contractors.

PERSONAL.

Mr. A. N. Hargrove, manager of the car department of Pierson, Roeding & Co., left on Wednesday morning for St. Louis and Philadelphia. While East he will visit the various factories of J. G. Brill Co. with a view to pushing forward the shipments of cars now building for Pacific Coast railroads. Pierson, Roeding & Co. report that during the past six months they have closed contracts for their principals, aggregating 144 cars with trucks, which is the equivalent of over $500,000 gross sales.

Jean Bart Balcomb of Brooklyn, N. Y., has resigned his position as chief engineer of the Pittsburg Filter Manufacturing Company, of Pittsburg, Pa., to accept a position as chief engineer of the Hudson River Concrete Company of New York City, with offices at No. 26 Court street, Brooklyn, N. Y.

Mr. H. G. Aylsworth has recently acquired an interest in the H. M. Estes Company, and will act as sales manager for this concern. The electrical lines formerly carried will now be represented by the Estes Company under the management of Mr. Aylsworth.

WESTERN ELECTRIC EMPLOYES DINE.

An informal dinner given to directors and department managers of the Western Electric Company was enjoyed by three hundred employes of the company at the Grand Pacific Hotel, Chicago, on the evening of January 28th. A minstrel show which followed the dinner proved a very enjoyable feature to all who listened to the many local jokes which were given.

President E. M. Barton delivered an interesting speech in which he reviewed the history of the company, which he said had grown from a small and comparatively insignificant organization to its present mammoth proportions.

Secretary C. G. DuBois, in his remarks, referred to the present status of the concern in the business world. His speech abounded in suggestions valuable to all interested in the system of conducting the business of a large corporation.

MONTANA WATERPOWER DAM COMPLETED.

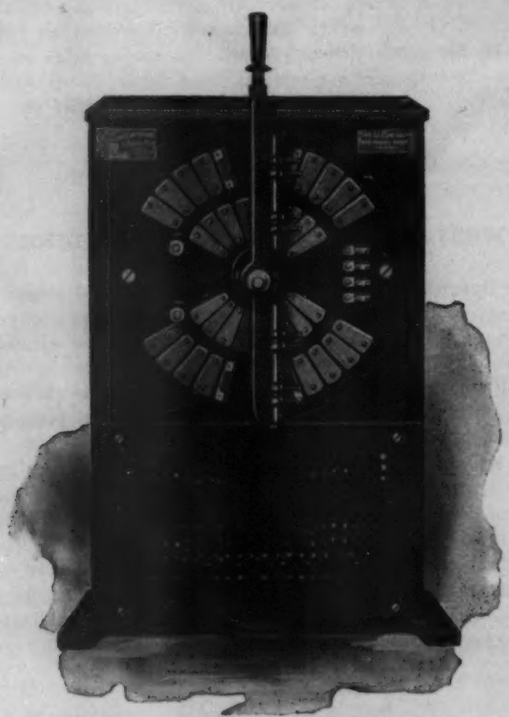
The gates of the Hauser Lake dam, near Helena, Mont., were closed last week. This is said to be the largest dam of its kind in the world, and is to supply the waterpower to develop electricity for running the Washoe Reduction Works, the Anaconda railway, light cities and operate many of the Butte mines. It will be three weeks before the power is turned on, as it will take this time for the lake to fill. The water will back up 18 miles in the river and through the Prickly Pear Canyon, six miles in the valley below Helena.

The dam is 640 feet long and 70 feet wide, and is made of steel throughout. Fifteen thousand horsepower will be generated, and this, with the Canyon Ferry plant, will make Helena one of the largest producers of electricity in the country.

INDUSTRIAL

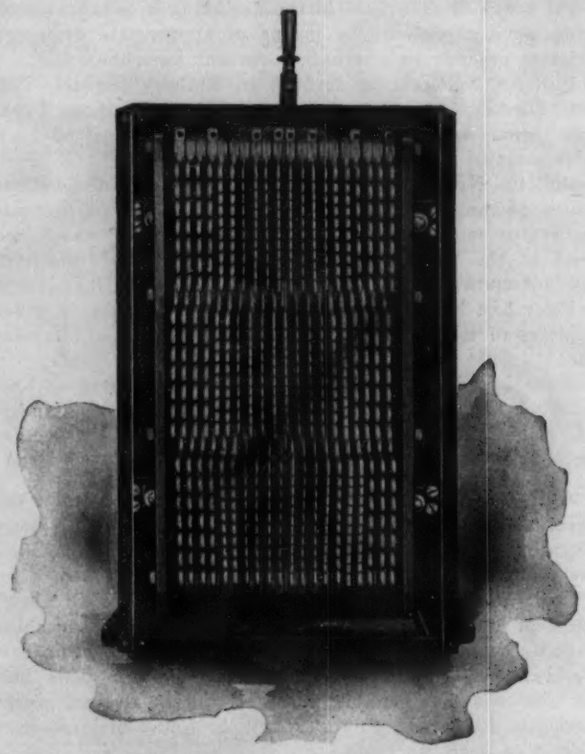
A NEW LINE OF CONTROLLERS.

The Electric Controller & Supply Co., of Cleveland, O., are placing upon the market a new line of controllers termed type G, which have a rating of 1 to 50 horsepower. These controllers were built to meet the requirements of general crane service where the conditions are not sever enough to demand the use of the Dinkey Ventilated Controller. The Type G-3 and G-4 Controllers are built with coil resistance and the Type G-5 and G-6 Controllers are built with cast grid resistance. When it is desired to place controllers above or in the rear of the operator the Type G Controller is furnished arranged for under lever operation. They are also furnished with spring return for operation from the floor by means of pendent ropes or chains. A number of crane users have decided that a 15 or 20 ton crane requiring a 25 or 30 horse power motor on the hoist and bridge motion may be operated from the floor by any of the men in the shop, thus saving the wages of a crane operator who would probably be idle half his time. It is a very simple matter to put cut outs at either end of the trolley travel and at either end of the run way to prevent accident. The Type G Controller meets this demand



TYPE G-5-CONTROLLER, FRONT VIEW.

for a controller up to 50 horse power arranged for operation from the floor by means of ropes. This controller is a self-contained unit, the resistance being placed in the frame, making it necessary to run only four wires between the controller and motor. Reversal is accomplished by the use of a single lever, no separate reverse switch being required. The Type G Controllers are self-contained, compact, and excessible. All parts are made to jig and are interchangable. The contact face is of heavy slate free from metallic veins. The contact segments are of copper which are screwed to brass lugs to which all wiring connections are made. By this construction any of the contact segments can be removed and replaced without disturbing the wiring connections. The contact arm is of soft cast iron and carries the fingers and finger holders, the insulation of which is of heavy pressed valcabuston bushings. The contact fingers are of dropped forge copper of great hardness and may be removed and replaced without removing the contact arm. A powerful and effective blow-out is provided in all sizes of these controllers. The frame for Type G-3 and G-5 Controllers consists of a main



TYPE G-5-CONTROLLER, REAR VIEW, CASE OFF, SHOWING RESISTANCE CONNECTIONS.

casting in one piece provided with a cover, the removal of which affords easy access to all resistance connections. The case enclosing this frame is of perforated steel, thus allowing ample ventilation. The frame of the G-4 and G-6 Controllers consists of a bottom casting which supports the resistance, and a top casting which supports the contact slate and arm. The top and bottom casting are connected by means of four steel corner posts around which a casing of perforated steel is provided for ventilation and protection to resistance. The top casting of the G-4 and G-6 Controllers supports the contract slate which is completely covered and protected by a sheet steel casing. This protects the operator from coming in contact with any live parts of the controller, and also protects the working parts of the controller from dust and dirt. Easy operation is secured by a lever which is keyed to the arm shaft at the back of the top casting, which gives a short movement of about 10 inches in either direction for both starting and reversing. The resistance for the G-5 Controller is built of cast grids in a single bank which may easily be removed as a unit without disturbing the other parts or moving the controller. The resistance for the G-6 Controller is made of two banks supported on bars attached to the frame, and may be removed in separate units without disturbing the other parts. The resistance for the G-3 and G-4 Controllers is made up of Type E coils which consist of a heavy asbestos tube stiffened by means of a central brass tube which serves to bring the rear terminal forward, facilitating the necessary connections. These controllers are very adaptable for service up to 500 volts. Six points of control are provided with the G-3 and G-5 Controllers, and eight points of control with the G-4 and G-6 Controllers.

WESTINGHOUSE SMALL POWER MOTORS OPERATING BEER PUMPS.

In the industrial and commercial field there are numerous operations requiring small amounts of power which have usually been laboriously performed by hand, owing to the lack of some convenient and inexpensive driving mechanism. With the growth of the electrical industry and its extension into new lines of work more attention has been given to the development and perfection of small power motors. In hotels, saloons and breweries, there are many applications such as bottle cleaners, automatic air compressors, beer pumps, etc. In Fig. 1 a Westinghouse ⅛-horsepower small power motor for alternating current circuits is shown driving a type "A" single-cylinder beer pump, for hotel and saloon use, manufactured by the E. R. Brown Beer Pump Company, of Boston, Mass. A Brown type "B" single-cylinder beer pump driven by a similar motor is illustrated in Fig. 2.

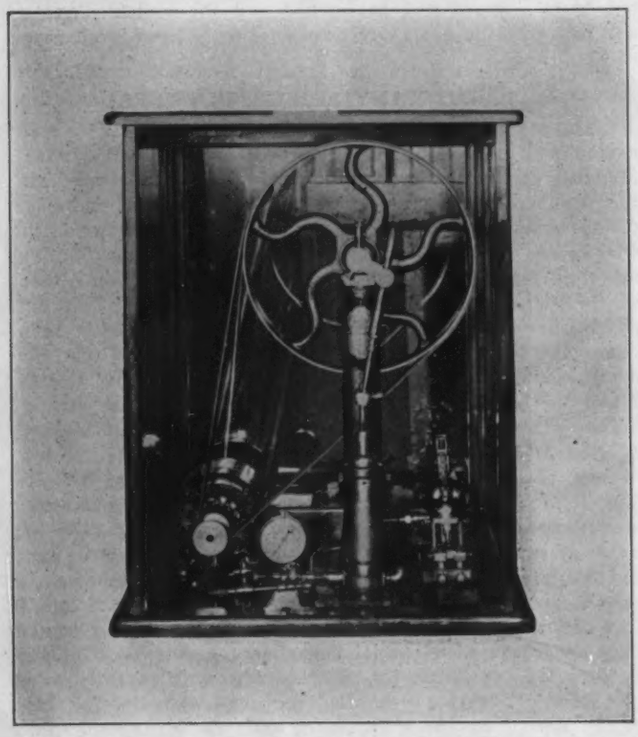


Fig. 1—Westinghouse Type "Da" A. C. Power Motor, ⅛ Horsepower, Driving Type "A" Beer Pump, Manufactured by the E. R. Brown Beer Pump Company, Boston, Mass.

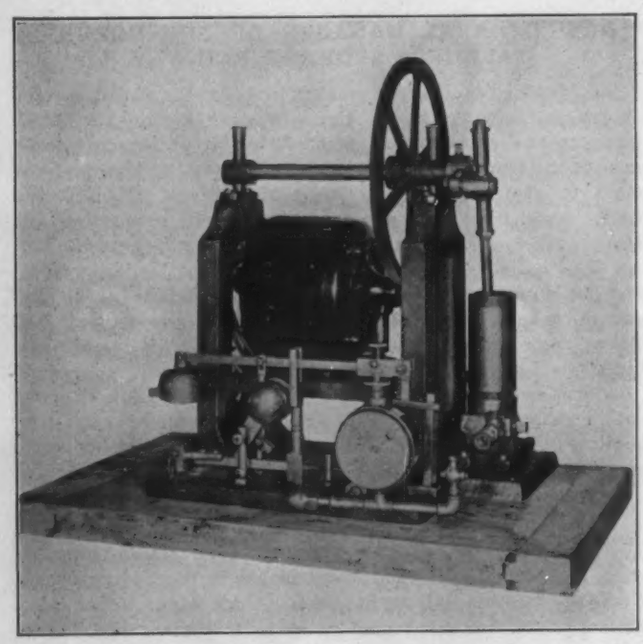


Fig. 2—Westinghouse Type "Da" A. C. Power Motor, ⅛ Horsepower, Driving Type "B" Beer Pump, Manufactured by the E. R. Brown Beer Pump Company, Boston, Mass.

These motors are compact, extremely neat in appearance, and thoroughly reliable in operation. They are built for both alternating and direct-current circuits, either 115 or 230 volts. The direct current motors are either shunt or series wound, and the alternating current motors are wound for 25, 60 or 133 cycles. The base of the motor consists of separate casting, the frame being drilled and tapped so that the feet may be fastened in any one of four positions, adapting them to use on floor, wall or ceiling.

EXTENDED TERMINAL ENCLOSED FUSES.

The Chase-Shawmut Company have just issued a folder describing their patented Extended Terminal Fuses.

Before the advent of National Electric Code Fuses, the manufacturers of enclosed fuses made a type "A," or screw-clamp contact fuse. In developing these fuses, the manufacturers, in many cases, made them up in different lengths for fuses of a given capacity. This fact has continually been a source of annoyance.

To obviate this, and to reduce and simplify the stock of type "A" fuses necessary for the user to have on hand, the Chase-Shawmut Company has developed and completed a line of fuses having a long or extended terminal on one end. This terminal is made of soft copper, and scored at different standard lengths. After once fitting the fuse to the base, the projections may be removed with pliers or hack-saw. This fuse will reduce the stock to one-third of the amount of fuses obliged to be carried before this Extended Terminal Fuse was developed.

CONVENTION OF ASBESTOS MEN.

Annual Meeting of the Sales-Staff of the H. W. Johns-Manville Co.

During the past week the various branch managers and department managers of the H. W. Johns-Manville Co. held their annual convention at the headquarters of the company, 100 Williams street, New York. This company has a world-wide reputation as being the largest manufacturers of asbestos, magnesia and electrical products in the United States, if not in the world, having factories at Brooklyn, Milwaukee, West Milwaukee and Hartford, Conn., and branch offices and warerooms in the following cities: Milwaukee, Chicago, Boston, Philadelphia, St. Louis, Pittsburg, Cleveland, San Francisco, Los Angeles, Seattle, Kansas City, Minneapolis, New Orleans, Dallas, and Buffalo. Representatives from the various branches and factories were present and the meeting was not only profitable but interesting to everyone present.

As a fitting finale, the convention wound up with a banquet at the Waldorf-Astoria, Friday evening, February 1st.

A LARGE PRODUCER GAS PLANT.

There is being erected at the works of the Simonds Canada Saw Company, Ltd., St. Remi, Montreal, the largest industrial producer-gas plant in Canada. It is of 600-b. horsepower capacity, and is to be used both for driving gas engines and providing gas for the various furnaces in the works. For almost a year Messrs. Simonds have had a 50-b. horsepower suction gas producer and engine operating part of their plant, and the great saving effected by its use has gone far in inducing them to make the present installation. The new plant consists of two independent producer units of 300-b. horsepower each, both having independent cooling and scrubbing apparatus, but discharging into one large gasholder of the gasworks type. After leaving the producers, which are of the Dowson type, the gas is first thoroughly cooled in a series of horizontal cast-iron coolers which have an exceptional radiating surface; it is then passed through a double water-sealed box of special design, thence through coke scrubbers of large capacity, and finally through dry purifiers. The gas is in this manner thoroughly cleansed of all tar, dust, and other impurities. The first of the large engines will be erected shortly, and will be a four-cycle single-cylinder horizontal unit of 150-b. horsepower.

This engine is of the special electric light type, having extended crank shaft with outer bearing and only one flywheel of extra large diameter, and weighing 10 tons. The crank-shaft bearings are of the continuous oiling type, similar bearings being also provided for the secondary shaft. The cylinder is provided with a removable liner, and all the valves are seated into loose boxes. The exhaust valve is fitted with the latest type of relief gear. A feature of the engine is its water cooling arrangements; independent water cooling is provided for the cylinder, piston, cylinder head, exhaust valve and exhaust valve seat. In this manner premature ignition due to over-heating of the parts named is eliminated. Ignition is effected by a powerful magnetic machine. The operator is provided with means of independently controlling the amount of air or gas, the time and intensity of the spark, and the engine speed. The engine is started quietly and easily by means of compressed air, one man only being required.

FILTERING PLANT IS OFFICIALLY OPENED.

John D. Spreckels, president of the Southern California Mountain Water Company, opened the valves of the new filter that has been constructed at Chollas Heights yesterday at 12 o'clock, and by this act was put into operation the largest and most modern filtering plant on the Pacific Coast. It is one of the only three such plants on the Coast, the other two being located at Berkeley and Oakland, but both of these are much inferior to the one just completed in San Diego. By the acquisition of this plant, San Diego will possess water that is unsurpassed by that of any city in the country for purity and healthfulness.

So mammoth is the filtering plant that Mr. Spreckels was occupied for fully fifteen minutes in turning the valves which released the water from the main pipes. The entire works were then placed in operation without a hitch of any kind. All of the great filters worked with the precision and thoroughness of clockwork.

The members of the company and others present when the valves were turned on by Mr. Spreckels were William Clayton, B. M. Warner, general superintendent of the company, Emory E. Smith, chemical engineer, and Mose Sisenvine, who was in charge of the construction of the plant.

The filtering plant has been in the course of construction for several months, and has cost about $100,000. The filter plant building covers an area of eighty feet by sixty-five feet, and there are ten filters, each twenty feet long and eight feet in diameter.

Emory E. Smith, of Smith, Emory & Co., of San Francisco, as chemical engineer for the company, had charge of the installation of the plant. Mose Sisenvine was the constructing contractor, and has been given high praise for the faultless work done on the plant, for, unlike most engineering feats of this proportion, there was not the slightest flaw found at the test made yesterday.

While the filtering plant has been put in operation, the water of the city reservoirs will not be affected for several days, as the flow has not yet passed from the filters into the reservoir. Only a limited supply of water was turned into the filters yesterday, for the purpose of washing out all sediment and to get the plant into good working order. It will probably be several days before this is completed, and then the by-pass gates will be opened and the undefiled water will pass into the great city reservoirs to be used in all parts of San Diego.

H. W. JOHNS-MANVILLE CO. IN BUFFALO.

The saying that "Nothing Succeeds Like Success" is well exemplified in the remarkable growth of the H. W. Johns-Manville Co. From a small beginning, half a century ago, this has become the largest concern in the world manufacturing asbestos, magnesia and electrical products, and the well-known reputation of the firm for producing nothing but the best is the factor which has contributed more than anything else to the company's success.

Within the past few months new branches have been opened at New Orleans, Dallas and Baltimore, so that the company now has sixteen branches throughout the United States, besides innumerable local representatives at various points. The business of the company in the city and vicinity of Buffalo has now reached such proportions that a new branch has just been opened at 214 Main street, Buffalo. This branch consists of a large retail store, offices and warerooms, and will be under the management of Mr. Geo. A. Schmidt, who for a number of years was connected with the Manville Covering Co., Milwaukee, which company is now a part of the H. W. Johns-Manville Co. Mr. Schmidt is well known throughout that section, having until recently been in charge of a special department of the W. A. Case & Sons Manufacturing Co., Buffalo, who until recently were the Buffalo agents of the H. W. Johns-Manville Co. Mr. M. F. Boscoe has been appointed assistant manager of this branch, and will make his headquarters in Rochester. Mr. Harry V. Patton, formerly manager for a local asbestos house, will also be associated with the new Buffalo branch.

NEW GENERAL MANAGER OF THE COEUR D'ALENE & SPOKANE RAILWAY.

Following the recent resignation of R. F. Blackwell as general manager of the Coeur d'Alene & Spokane Railway, comes the announcement made by Jay P. Graves, president of the Spokane & Inland Empire System, of the appointment to that position of Clyde M. Graves. Mr. Blackwell's resignation will not take effect until some time in March, when Mr. Graves will assume the management.

R. F. Blackwell was one of the original incorporators and builders of the Coeur d'Alene line and has been its general manager since its inception, three years ago. He leaves the road to devote his entire time to his lumber interests.

Mr. Graves will continue in his present position as general manager of the Spokane Traction Company after assuming the management of the Coeur d'Alene division next month.

STEAM PLANT IN FLOUR MILL.

The Tracy Engineering Company are installing one of their high economy steam power plants in the Sperry Flour Company's cereal mill at Stockton. Edge Moor water tube boilers, Nordberg compound condensing engine, and Tracy economy devices will be used. The Sperry people now have several Tracy power plants in operation and are getting results that warrant them in using steam instead of electric power.

NEWS NOTES

ELECTRIC RAILWAYS.

Spokane and Inland Empire Railroad System.—Progress is being made at the company's million-dollar plant at Nine-Mile Bridge, where the waters of the Spokane River are being harnessed to furnish 12,000 horsepower for operating railway lines and furnishing light and power. William F. Zimmerman, representing the company, is consulting engineer, the designing and constructing engineers being Sanderson & Porter, and the work is being carried forward under the supervision of F. M. Sylvester, local manager. The development of power is being accomplished by diverting the river with a flow of 12,000 cubic feet the second, from its natural channel. The dam will be 75 feet at its base, and 225 feet in length, exclusive of the power house, 110 feet wide by 87 feet by 87 feet above the low water mark, forming part of the dam, which will create a head of water of 60 feet, also backing the water a distance of five miles, thus furnishing an immense storage, to carry large fluctuations of load. The plant is designed to accommodate from 5,000 horsepower units, two of which are being installed. The electric generators will be 3,750 kilowatts, three-phase, 2,200-volt, 60-cycle alternators. The plant will be in operation the coming year.

Spokane and Inland Empire Railroad System.—Storage batteries, costing more than $200,000, have been installed on the Coeur d'Alene and the Spokane and Inland lines, and in connection with these is the frequency changing station costing $300,000. The company buys its power from the Washington Water Power Company, on a basis of $20 the horsepower a year for 24 hours' service. To take care of the surplus energy occasioned by light loads on the lines the battery system is employed. The battery contains 275 cells, and through it the "peak" load is kept at the average level, making a saving of 30 per cent. At the frequency changing station, the current, which comes direct from the power company's feed wires, is raised by transformers to a voltage of 45,000 and made an alternating current. At the sub-stations, four of which will soon be in operation, the current is reduced to a voltage of 6,000 for operating trains. The current is reduced every 12 miles.

Spokane and Inland Empire Railway System.—President Jay P. Graves' application for a franchise to build a million-dollar subway on Main and Front avenue, to connect the freight terminal with the main passenger station, a distance of nearly a mile, has been granted by the City Council of Spokane, and it is given out that work will begin in a short time. The subway will be double tracked, 30 feet deep, built of concrete and stone. The franchise provides that it must be completed in five years, but Mr. Graves says it will be ready in half that time. The purpose is to afford rapid transit within the city limits. As the franchise permits the use of steam and electric lines it is not unlikely that the Chicago, Milwaukee and St. Paul, the North Coast and the Kettle Valley Railway lines will use it to gain entrance to the heart of the city.

Northwestern Gas & Electric Light Company.—Officers of the company, controlled by capitalists from Philadelphia, are searching for another source of power. Since coming into possession of plants at Walla Walla, Baker City, Pendleton, Milton, Weston, The Dalles, Salem, Eugene and other places in Oregon and Washington, it has reached the limit of its capacity. The falls in the Deschutes River in Oregon to generate power for plants in Western Oregon and Washington. Engineers who have examined the falls give the opinion that power for several times the present requirements of the plant can be generated there. The plant furnishes electric light and power for Walla Walla, Pendleton, Athena, Milton, and Weston. Since the Walla Walla street car system has been in operation the plant has been more heavily taxed than ever, and competition of the inter-urban line from Walla Walla to Milton and Freewater will exhaust its capacity.

Idaho Northern Railroad.—This company, building a railroad from Kingston to Murray and from Kingston to Coeur d'Alene, Ida., is planning to continue its line into Spokane. It is understood that practically all the right of way has been secured. The right of way from Kingston to Coeur d'Alene by way of Fourth of July Canyon and from Kingston to Wallace, the famous lead-silver mining camp, is also complete. The entrance to Spokane will be through Greenacres and by way of East Sprague avenue.

Columbia and Walla Walla Traction Company.—J. H. Morrow, manager, has received an offer of terminal and depot grounds and right of way from the people of Dayton, Wash., as an inducement to build the line over the original survey. He prefers that route. The plan of a connection with the Graves' lines was discussed by Mr. Morrow and Jay P. Graves at a conference in Spokane recently, with a view of giving the latter an outlet to the Columbia. This could be provided, as the Columbia and Walla Walla Traction Company's terminal is at Wallula.

Bellingham, Wash.—S. L. Shuffleton, constructing engineer, states construction of the local interurban electric railway to be built by Stone & Webster will be started within two months.

Seattle, Wash.—The Seattle Electric Co. will double-track their Georgetown line from the Grant-street bridge to Georgetown.

Spokane, Wash.—The Spokane & Inland Railway Co. has applied for franchises for two single track branches with switches and side tracks in alleys between Riverside and Main avenues.

Portland, Ore.—Plans have been completed for beginning work on the Front street line of the United Railways Co., L. B. Wickersham, chief engineer.

Seattle, Wash.—The Seattle Electric Co. and the Seattle, Renton & Southern will apply for a franchise on Letitia street, between Hudson street and the city limits.

Tacoma, Wash.—The Electric Logging Company has petitioned the county commissioners for a franchise to build a logging railroad at its camp on the Tacoma Eastern.

Tacoma, Wash.—Grading on the new Puyallup line of the Tacoma Railway & Power Co. is progressing rapidly.

OIL.

Grass Valley, Cal.—The fuel-oil shortage has reached alarming proportions. The representatives of the Associated Oil Co. here have been unable to get in a single barrel for over two weeks. Their reservoir, which supplies a number of the largest mines in the district, is empty, and only one tank car obtained is unknown, and the famine is causing grave apprehension among the mines affected. Already the Conin mine has been forced to suspend for lack of crude petroleum for its furnace, and the surface water is running down the shaft. The Pennsylvania and the Central Shaft also oil consumers. The Narrow Gauge line is also affected, but luckily it has but one oil-burning locomotive now in commission.

POWER AND LIGHT PLANTS.

Falls City, Ore.—Mr. Newson of Rainier, Ore., has applied to the council for a franchise for an electric light and power plant.

Portland, Ore.—The Oregon Gas Mfg. Co. has been incorporated by A. King Wilson, O. A. Neal and J. A. Arment. Capital, $100,000.

Tacoma, Wash.—City Electrician A. L. Thom plans to overhaul and reconstruct the lighting plant in the downtown district. Heavy copper mains will be strung in place of the lighter wires now in use and large transformers will be substituted for the smaller one. The cost will be over $50,000.

West Seattle, Wash.—The Seattle Electric Co. and the Seattle-Tacoma Power Co. will apply for lighting franchises.

Oroville—The Great Western Power Co. has completed preliminary operations at Big Bend, and active development work has begun. At present 300 men are at work, and the force is to be increased to 600. The old Big Bend tunnel is to be enlarged and lined with solid concrete masonry. It will have an inside measurement of 235 square feet. A new tunnel, 3,500 feet long, will be driven from the end of the old tunnel up the North Fork of the river. From the outlet of this tunnel the water will be carried to the power house in pipes. Present plans call for the development of 50,000 horsepower, and the total capacity of the plant will be 100,000 horsepower. The total fall of the water will be 535 feet. The company figures on a total expenditure of between $5,500,000 and $6,000,000.

Ely, Nev.—The power plant of the Ely Electric Light and Power Co. is nearly completed and within the next 30 days the town of Ely will be supplied with electric lights, and several of the hoists on the mines in this vicinity will also be operated with electrical power. The plant is to be one of the largest in the State and is the first to be built in this portion of Nevada. It will not only be used to light Ely and a number of small camps in this vicinity, and to operate the hoists and machinery in a number of the Ely mines, but the power will also be used in operating an electric car line between Ely and the smelter site several miles from Ely. A company has already been formed to build. The smelter site will be connected with Ely by a modern electric car line.

Red Bluff—The Pacific Power Co.'s operations on Battle Creek are being pushed. Men are at work clearing a site for the power plant, while others are building houses for themselves and families. Everything will soon be in readiness for the building of the first power plant. The second plant will be built on a much larger scale and will be commenced soon after the completion of plant number one.

Redding, Cal.—The Northern California Power Company is having plans made in San Francisco for a fine office building that will be erected in this city on the company's lots opposite the court house. The building will be constructed of concrete, with fancy brick trimmings, in the old Spanish style of architecture.

Spokane, Wash.—The Cheney Light & Power Co., capital $25,000, has been incorporated by H. L. Bleecker, Charles P. Lund and W. S. Gilbert.

Spokane, Wash.—The Spokane Gas Light Co. is planning to build a water gas plant at a cost of $65,000.

Twin Falls, Ida.—The Telluride Power Co. has applied for a franchise to supply the town with light and power.

Waverly, Wash.—The Waverly Water Works and Light Co. has been incorporated by Arthur D. Jones, J. P. Graves, F. Lewis Clarke and others. The company will erect a large plant for electric lighting and for their water works plant at a cost of $50,000.

TELEPHONE AND TELEGRAPH.

Asotin, Wash.—F. B. Simpson, who has had supervision of the Asotin Tel. Co., has sold his interest to J. N. Cunningham of Clarkston for $3,500.

Asotin, Wash.—A Farmers' Tel. Co. has been organized by C. E. Zimmerman, Walter Sangster and W. F. Hurst.

Bellingham, Wash.—F. D. Fobes, Dr. Graffin and H. J. organized by Henry Richardson, N. C. Davenport, Enos Strode and J. H. Oltmanns. The company has applied to the county commissioners for a franchise to construct a line from the city limits along the Guide Meridian road to Laurel and thence to Ferndale.

Belingham, Wash.—F. D. Fobes, Dr. Graffin and H. J. Strickfaden have secured a franchise to build a telephone line between this city and Maple Falls.

Bellingham, Wash.—The Ten Mile Tel. Co. was organized at Ten Mile by J. C. Miller, representing the Sunset Tel. Co. The officers are J. N. Nygran, president; Furman D. White, secretary, and N. Jordal, treasurer. The line will run from the Ten Mile school house to the Guide Meridian road and follow that highway to this city.

Dillon, Mont.—The Dell Tel. Co. has been organized with a capital of $10,000. Frank A. Hazelbaker, secretary and general manager. The company will build a line from Dell to Sheep Creek Basin and other parts of the county.

Fernie, B. C.—The Revelstone Trail & Front Lake Tel. Co. will build a long distance line to Elkmouth and Hosmer.

Big Harbor, Wash.—A committee composed of A. E. Johnston, M. V. Iliff, and W. H. Rust was appointed to confer with telephone companies in Tacoma with a view to establishing a line from Tacoma to this place.

Grangeville, Ida.—C. McDaniels, manager of the Buffalo Hump Tel. Co., is building a telephone line from Concord to Oro Grande.

Kelso, Wash.—Under the direction of J. D. Eaton a crew is now at work here mapping out the route for the new line of the Northwestern Long Distance Tel. Co.

Port Townsend, Wash.—The Independent Tel. Co. has completed the construction of a line between this place and Port Ludlow, and work is now under way for construction of a line to Seattle.

Sheridan, Ore.—The Sheridan Independent Tel. Co. has been incorporated by Charles W. Buell, J. K. Gutry, and R. V. Stockton; capital, $4,000.

Warren, Ida.—Mr. Friar states that arrangements have been completed for the construction of a telephone line from Ramey ridge to this place. John T. McCoy is president of the company.

Sherwood, Ore.—The Sherwood Mutual Tel. Co. has been incorporated by J. P. Young, L. S. McConnell and Fred Langer.

Crockett, Cal.—It is learned that the Pacific Telephone & Telegraph Company is gathering data and forming plans to improve the system. These plans provide for the locating at Crockett of a central station, for the territory between Port Costa and Tormey. Information says a great change in service along water front will be made.

Phoenix, Ariz.—E. L. Bumpus, Arizona manager for the Pacific Wireless Telegraph Company, states that the company will have stations in Phoenix, Tucson, Bisbee and Prescott within a year. The company owns its own manufacturing plants.

New York, N. Y.—An increase of ten per cent. in the salaries of telegraph operators at the company's principal offices throughout the country was conceded by the Western Union Telegraph Company recently.